Summary of Results
Middle Truckee River Bioassessment Project
"Fine Sediment Deposition and Invertebrate Communities in the Middle Truckee River, California: Development of Criteria for Establishing TMDLs"

By Bud Amorfini
Environmental Scientist
Lahontan Regional Water Quality Control Board

February 27, 2007

Overview

The Lahontan Water Board commissioned a study of the middle Truckee River (between Tahoe City and the California-Nevada state line) with the University of California's Sierra Nevada Aquatic Research Laboratory (SNARL). The purpose of the study was to assess whether beneficial uses of the Truckee River were impaired by sedimentation. The study approach focused on measuring fine sediment deposition at sampling sites located upstream and downstream of tributaries entering the main-stem Truckee River and correlating the measurements with bioassessment results at each of the sites. Bioassessment is the study of benthic macroinvertebrate communities and is considered representative of aquatic life beneficial uses.

Researchers hypothesized that downstream sediment deposition could be compared with upstream deposition to help assess how sedimentation may be affecting the system. It was expected that upstream sediment volumes would be found at greater volumes than at upstream locations and that the sediment volumes would be related to estimates of tributary loading.

In summary, invertebrate communities showed expected responses to increasing sedimentation, but there were no consistent patterns of sediment deposition to discern potential sources. Sediment volume measurements were not necessarily greater at downstream locations compared with upstream locations. Results did show that increasing levels of sediment adversely affect invertebrate communities. The complete SNARL report with references may be found at the website for the Truckee River Sediment TMDL[1]. The Lahontan Water Board staff's review and summary of the study follows.

[1] http://www.waterboards.ca.gov/lahontan/TMDL/Truckee/Truckee_Index.htm

Summary

Study Plan

Researchers determined that standard bioassessment techniques (e.g., targeted riffle method) are not ideal for assessing invertebrate communities in the Truckee River. Additionally, other data would be needed to evaluate if sediment were the cause of any observed aquatic life degradation and to assess potential source areas. Therefore, an innovative approach was developed to evaluate invertebrate communities and the effects of sedimentation on these communities.

Sites near seven tributary confluences with the Truckee River were selected for evaluation. The tributaries included Bear Creek, Squaw Creek, Trout Creek, Martis Creek, Juniper Creek, Gray Creek, and Bronco Creek. Modeled estimates of sediment loading for the years 1996 and 1997 were previously developed for each of these tributaries by DRI in 2001. This information was considered by researchers to potentially test dose-response relationships between sedimentation and bioassessment results.

The study plan was developed based on the hypothesis that sedimentation would be most evident in the channel margins of the Truckee River because flow velocities are typically lower in this portion of the channel. It was anticipated that upstream sampling points would show less fine sediment deposition than downstream sampling points. It was also hypothesized that downstream sedimentation would be greater at tributary sites with higher modeled load estimates. If the hypotheses held, bioassessment results could provide quantitative information on aquatic life impairment related to sedimentation and help identify source tributaries.

Field sampling was conducted in September 2004. At each tributary confluence, six pump-core samples and one targeted riffle sample were collected. Pump-core sampling consisted of collecting deposited sediment samples and invertebrate samples from the channel margins of the Truckee River. One upstream site and five downstream sites were sampled at each of the seven tributary locations. Pump-core sediment volumes were reported in units of milliliters (ml).

Although researchers did not consider targeted riffle sampling as the best evaluation method for the Truckee River, samples were collected to add to the breadth of information on aquatic life conditions. Targeted riffle sampling consisted of collecting invertebrate samples from riffle habitat in the main channel of the Truckee River, downstream of tributary confluence locations. Sampling sites included the seven tributaries identified above plus an additional site called Canyon 24.

A suite of invertebrate community metrics was calculated for both the pump-core samples and the targeted riffle samples. Selected metrics were compared among sites, to sediment pump-core volumes, and to modeled loading estimates. Additionally, targeted riffle invertebrate samples were compared to a provisional 10-metric Index of Biological Integrity (IBI) score.

Results

Pump-core sediment volumes ranged from 4.5 to 570 ml, but the sample volumes were biased toward the lower third of the range (39 of 42 samples were 210 ml or less). Sediment volumes did not show statistically significant differences between upstream and downstream sampling sites, or a consistent pattern of sediment deposition between tributaries and their respective modeled load estimates. Pump-core measurements near Trout Creek were determined by the researchers to be outliers; therefore, the results from this location were not included in further evaluations.

Invertebrate communities sampled at each pump-core site showed expected responses (less biological integrity) to increasing volume of sediment. However, because sedimentation measurements were not consistent with anticipated up- and downstream relationships or loading estimates, likely sources could not be determined.

Although it is unknown whether the sediment volumes represent excess sediment relative to natural background conditions, researchers reported that sediment tolerant invertebrate communities become most evident at sampling sites with a pump-core sediment volume of 100 ml or greater. It was reported that approximately half of the 36 invertebrate samples showed loss of integrity and that this observation corresponded with a sediment volume of 100 ml or greater.

Results of the targeted riffle samples were evaluated with respect to a provisional IBI scoring system. The scoring system was developed based on bioassessment work previously conducted at selected first through fourth order reference streams and other test sites in Eastern Sierra watersheds. Although the reference streams are not necessarily directly comparable to the Truckee River (fifth to sixth order), researchers suggest that an IBI score of 62 or less is indicative of impaired conditions. Three of the eight targeted riffle sites showed IBI scores of 62 or less. A summary of the IBI scores is presented below.

Tributary Confluence	IBI Score
Bear Creek	55
Squaw Creek	67
Trout Creek	77
Martis Creek	60
Juniper Creek	62
Gray Creek	76
Bronco Creek	80
Canyon 24	67

Staff Analysis and Conclusions

In general, study results were inconclusive because downstream sample sites did not consistently show greater volumes of sediment compared with upstream sample sites. Similarly, no relationship was found between estimated tributary loading and channel margin sediment volumes; therefore, the results did not reveal new information on potential source tributaries. To help describe the mixed results, staff rank-ordered selected parameters for each sampling site. The rankings are shown in Table 1 and Figure 1 below.

Table 1. Comparison of Upstream and Downstream Sediment Volumes

Pump Core Sediment Volume Rank (Least to Most Sediment)
Bear Creek - Downstream
Squaw Creek - Downstream
Juniper Creek - Upstream
Juniper Creek - Downstream
Squaw Creek - Upstream
Martis Creek - Upstream
Gray Creek - Downstream
Bronco Creek - Upstream
Gray Creek - Upstream
Bronco Creek - Downstream
Bear Creek - Upstream
Martis Creek - Downstream

As shown in Table 1, relationships between sediment volumes in up- and downstream sites did not conform to the study hypothesis. If the hypothesis held, it would be expected that upstream sites would consistently show less sediment volume than their associated downstream sites. This was the case in only half of the sites.

As shown in Figure 1, relationships between the four study parameters vary significantly. If anticipated assumptions held, it would be expected that rankings for each parameter would be reasonably consistent. In particular, the rankings do not show clear relationships with modeled load estimates that would reveal potential sources associated with specific tributary inputs.

The rankings in Figure 1 also do not show a clear relationship between channel margin sedimentation and IBI scores (invertebrate community health) in the main channel of the river. Half of the sites show a reasonably consistent relationship and half of the sites do not. This is likely due to higher stream-flow velocities in the main channel that would carry suspended sediment downstream until velocities would be low enough for sediment to settle out.

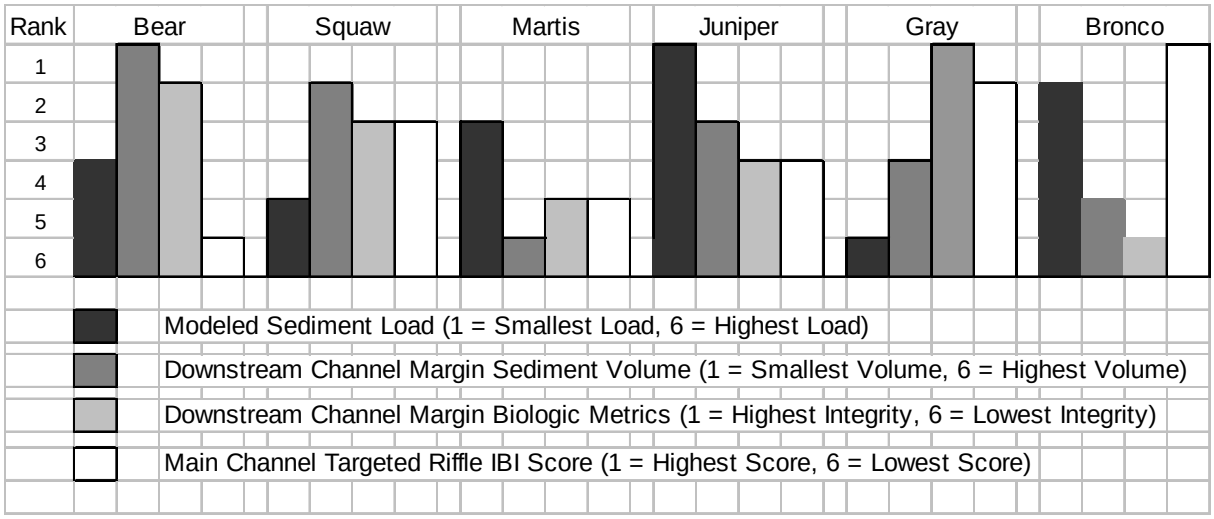

Figure 1. Comparison of Sediment and Bioassessment Parameters

Rankings related to increasing channel margin sediment volumes and degraded biologic metrics are reasonably consistent. Overall, this relationship indicates that sedimentation in the Truckee River does adversely affect invertebrate communities.

Recommendations

A watershed protection plan to assist in controlling sediment loading to the Truckee River is warranted, particularly considering the significant growth planned in the watershed, because the study results show that invertebrate communities are adversely affected by increasing levels of sediment. Staff recommends preparing a sediment TMDL for the Middle Truckee River watershed.